# THE SIDEREAL MESSENGER.

CONDUCTED BY WM. W. PAYNE,
DIRECTOR OF CARLETON COLLEGE OBSERVATORY.

OCTOBER, 1889.

*Thou, Lord, in the beginning hast laid the foundation of the earth, and the heavens are the works of thine hands.*

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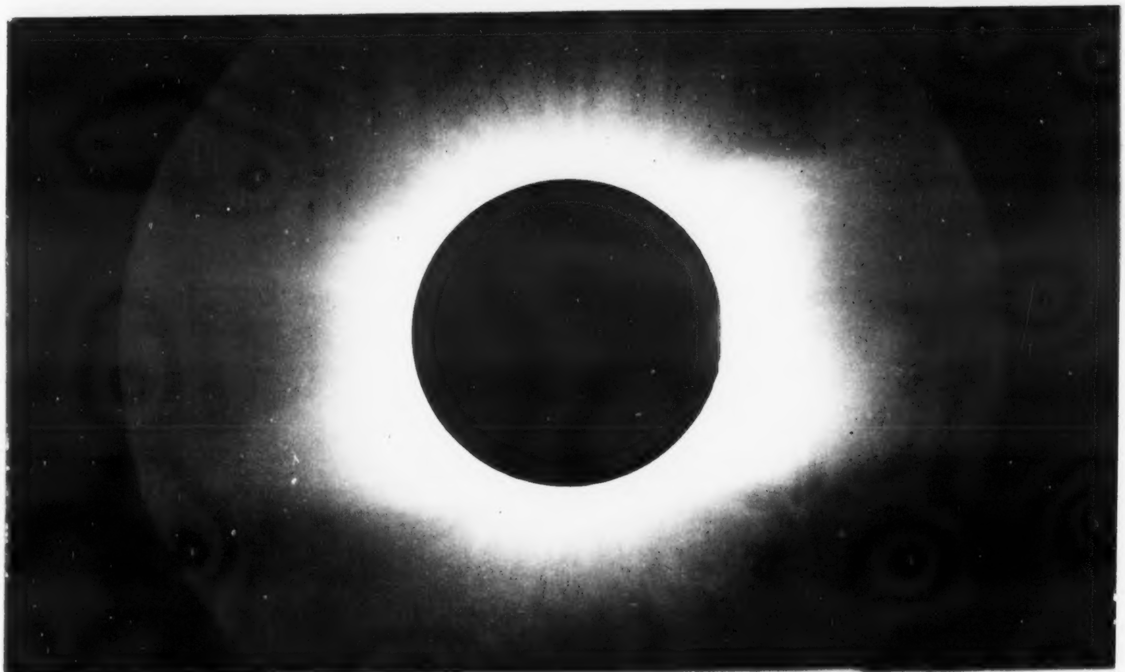

BOSTON PHOTOGRAVURE CO.

TOTAL SOLAR ECLIPSE. JANUARY 1, 1889.

The Sidereal Messenger,

CONDUCTED BY WM. W. PAYNE.

Director of Carleton College Observatory, Northfield, Minn.

Vol. 8, No. 8. OCTOBER, 1889. Whole No. 78.

## THE TOTAL SOLAR ECLIPSE OF JANUARY, 1889.

WILLIAM H. PICKERING.

For The Messenger.

The frontispiece accompanying this number is from a negative of the corona taken with the thirteen-inch visual photographic telescope belonging to Harvard College Observatory. No enlargement is used in the reproduction which is on the original scale of $42''.4$ to one millimeter. It is so oriented that the north point of the corona is towards the bottom of the picture, the middle circle of declination being nearly parallel to the edge of the plate. The original negative was taken on a Seed plate, sensitometer number 26, with an exposure of two seconds. It was taken at the extreme end of totality, and the sun had already begun to appear around the western limb of the moon. It is probable that the sun came out only a minute fraction of a second before the exposure was closed, as otherwise the plate would have been badly fogged. As it is, no trace of fog appears upon the negative, as is shown by the perfect transparency of the disc of the moon. On the other hand the sky around is quite brilliantly illuminated, the field of the telescope appearing as a well defined ring. It is this outer structureless corona which furnishes at present the chief impediment to the disproval by means of photography of the existence of any considerable body revolving between Mercury and the sun.

It is also on account of this diffuse illumination that there is no advantage to be gained by using more rapid plates than those at present employed for this class of coronal photography. If the inner corona really does extend further out from the sun than we are at present able to photograph, which is perhaps doubtful, we shall approach nearer its

limits by using plates giving greater contrast, not greater sensitiveness. Most of my photographs with this instrument were taken on Carbutt H plates, which give much stronger contrasts than the Seed, and enable one to make a much better study of any given part of the corona; the short exposures being suitable for the inner portions, and the long exposures for the outer. But for a general view of the whole corona, one needs a plate giving less contrast, but greater range. A negative taken upon a Seed plate was therefore employed for the present purpose.

The prominent feature of this corona is the great ring of light lying nearly in the plane of the ecliptic, whose cross sections we see to the east and west of the sun. This has now for the third time been shown as characteristic of the sun during its quiescent state. On both sides this ring is seen to be distinctly cleft into two portions, a northern and a southern one, the dividing notches coinciding nearly with the sun's equator. On the original negative these sections are seen to be striped by curved lines and rays, whose general direction is radial. Some of the stronger of these are faintly shown in the reproduction. After the double ring the most prominent features of the corona are the two sets of polar rays, some of which in the northern group extend to the length of four hundred thousand miles. These rays are frequently slightly curved, being convex to the pole, and seem to radiate from two points on the polar axis, situated about one hundred and fifty thousand miles below the surface. The rays furthest from the pole are in general the most curved. In the original negative one can see the chromosphere extending around the western limb of the sun through 140°, and rising three thousand two hundred miles above its surface. Unfortunately in the reproduction this could not be shown at the same time as the outer portions of the corona. Several protuberances are also visible upon the negative, including one completely detached from the limb.

Twenty-nine observers were occupied in manipulating the different instruments at the time of the eclipse, and the same plan of organization as that first tried at Grenada in 1886 was employed. One man furnished with a metronome was charged with counting seconds for the rest of the party, be-

ginning the moment he received the signal of totality. The other observers were stationed at the different instruments, and each had his own particular piece of work to perform. Thus the plate-holders were inserted in the thirteen-inch telescope by Mr. E. T. King, the exposures were made by Mr. E. Lehorn, the seconds were counted by Mr. Dexter, and the times at which the lens was capped and uncapped were recorded by Messrs. Carter and Eilerman. Finally, the plates were developed by myself. In all between forty and fifty negatives were secured, which will furnish enough material for many months' computation and study.

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## THE LICK OBSERVATORY EXPEDITION TO OBSERVE THE SOLAR ECLIPSE OF DECEMBER 21, 1889.

EDWARD S. HOLDEN.

For The Messenger.

The Editor of The Sidereal Messenger has asked me to contribute a full statement of the plans which will be followed in the observations of the solar eclipse of next December, and I am very glad to accede to his polite request. The eclipse of last January was observed by a party from the Lick Observatory and the results there obtained seem to be both interesting and important. The report of this work has been in type for some time and will shortly be in the hands of those interested. Therefore I will content myself with a mere reference to this work.

A very important result of the eclipse observations of January, 1889, was the discovery of a remarkable extension to the outer corona. This is shown on the negatives of the Lick Observatory by Mr. Barnard, on those of several of the California amateurs (especially on the negatives of Messrs. Ireland and Lowden), and also on the beautiful negatives of P. Charroppin who was attached to Professor Pritchett's party. It is presumably shown on the admirable series of negatives obtained by Mr. Pickering in charge of the party of the Havard College Observatory, and very likely it is to be found on other negatives which I have not seen.

Its existence is beyond all doubt. Under these circumstances it seemed very desirable to attempt to secure pho-

tographs of the December eclipse with the principal object of tracing this new extension still further from the limb, but the Lick Observatory was not in a position to incur the considerable expense of sending a special expedition to South America, and so the plan was reluctantly given up. Fortunately our situation was made known to Hon. Charles F. Crocker, a regent of the University and a member of the Astronomical Society of the Pacific. Mr. Crocker at once volunteered to personally bear the expense attending such an expedition including the purchase of the necessary instruments, etc.

This generous offer has made it possible to undertake an expedition, thoroughly equipped for photographic operations. The regents of the University have authorized the use of any of the portable instruments of the Lick Observatory, and have also given a leave of absence to Messrs. Burnham and Schaeberle who will do the work. Capt. R. L. Phythian, U. S. N., Superintendent of the Naval Observatory, has kindly lent us one of the six-inch Dallmeyer cameras of the Washington Observatory, and Mr. Blinn, of Oakland, has also aided us materially by the loan of minor apparatus. Before obtaining the loan of the U. S. N. O. camera, we had purchased from the eclipse fund a six-inch Willard portrait lens, the same one which was so successfully used by Mr. Ireland in January last.

The objects of the expedition are, in the order of importance:

1st. To obtain negatives of the inner corona showing all the detail possible from the limb outwards. This work will be done by Mr. Burnham with our 6½ inch Clark telescope with its aperture reduced to 3 inches (chemical focus = 76.63 inches). The exposures will be 2, 5, 7, 10, 25 seconds on Seed 26 plates. Two of these plates will be standardized to permit of photometric measures. A long dew-cap will be used with each photographic instrument to exclude atmospheric glare.

2d. To secure photographs of the extension of the outer corona. Mr. Schaeberle will do this work with the six-inch U. S. N. O. camera. At least four Seed 26 plates will be exposed for 10, 15, 20, 25 seconds respectively. Two of these will be standardized.

3d. To secure a photograph with a small camera immediately after contact III on a standardized plate for use in measures of the brightness of the sky, etc. Mr. Burnham will expose this plate.

After the eclipse is over, the astronomers will remain at Cayenne for a short time. We all know what to expect if Mr. Burnham has a 6½ inch Clark telescope at his disposition for a month or two, in a field as uncultivated as the southern sky. Mr. Schaeberle will utilize this time to carry on an investigation (already begun here) on the photographic atmosphereic absorbtion from the zenith to 70° or 75° Z. D. He will also be able to determine the brightness of several of the more important southern stars in terms of that of Polaris.

The eclipse photographs will (probably) be developed shortly after they are made and by next Christmas Day, at latest, we may expect to hear of the success of the expedition. If the day is clear there can be no doubt as to the results.

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## THE NEW DEARBORN OBSERVATORY.

G. W. HOUGH, DIRECTOR.

For THE MESSENGER.

In the fall of 1887 the old site of the Dearborn Observatory in Chicago was abandoned, and the instruments transferred to the Northwestern University, at Evanston.

The new building is a gift of James B. Hobbs, Esq., of Chicago, and was erected at a cost of twenty-five thousand dollars. The new location is about sixteen miles north and three miles west of the old site in Chicago.

The site for the building is on the grounds of the Northwestern University three hundred feet from the shore of Lake Michigan, and the same distance from the street.

During the first year the Repsold Meridian Circle has been temporarily mounted near the lake shore. The usual nadir observations by observing the image of the wires of the Meridian Circle, when directed over a basin of mercury, were made a number of times each week, and it was found that such observations were possible at all times. During a heavy

storm, however, the image was somewhat disturbed, but the tremors were not such as would interfere with ordinary observations. It is a well known fact that one of the most annoying troubles of the astronomer, the world over, is the inability to make nadir observations when most desired. At the old site of the Dearborn Observatory, as well as at Evanston, nadir observations are very easily made; the freedom from disturbance in this vicinity is undoubtedly due to the fact that the surface soil to a considerable depth is composed of sand and gravel, through which vibrations are not readily transmitted.

The plans for the new building were prepared by Cobb & Frost, architects, under the supervision of President Joseph Cummings, and, before being adopted, were submitted to the building committee, consisting of James B. Hobbs, Joseph Cummings, J. Y. Scammon, and Elias Colbert, and every detail was carefully considered. It was the aim of the committee to secure a building which should have architectural merit and at the same time be well adapted for scientific purposes.

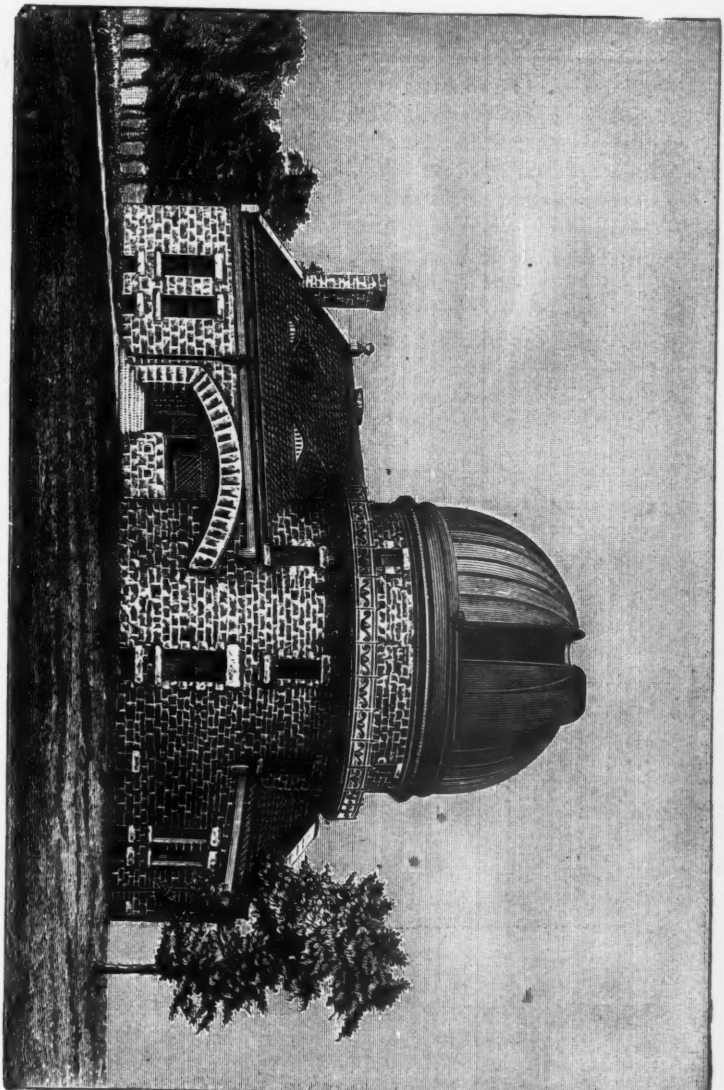
The erection of the building was in charge of Dr. Joseph Cummings, who, from the time of locating the site until its final completion, has given to it almost daily attention. The successful carrying out of the plans is largely due to his constant oversight.

The accompanying wood-cuts will show the style of architecture and the arrangement of the rooms. The exterior is of rubble limestone, level in the vertical joints and horizontal beds, and trimmed with tooled and carved Bedford stone. The cornices and gutters are of copper, while the entire roof, with the exception of the dome, is covered with Akron red tile.

The building is eighty-one feet in length from north to south, and its greatest breadth is seventy-one feet. There is a cellar extending under the entire building, which is used for the furnace, batteries, and other purposes.

The front entrance is on the west side, and communicates with a spacious hall-way extending through the building from west to east.

On the southeast side is the meridian-circle room, 26×35 feet in size, giving ample space for the telescope and acces-



THE NEW DEARBORN OBSERVATORY.

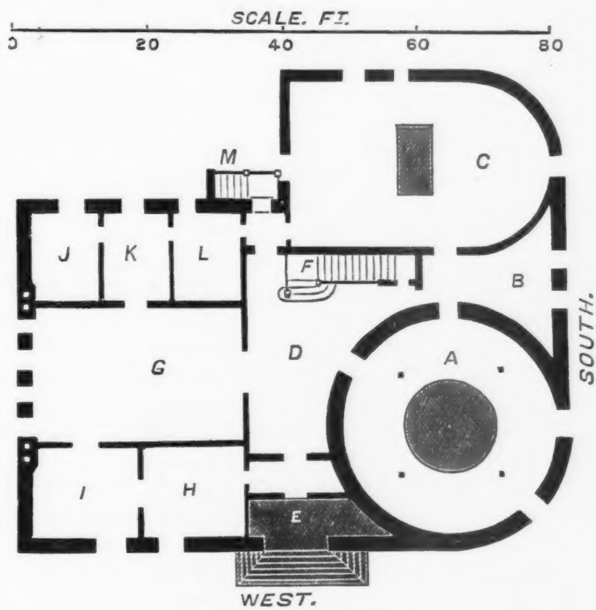
sory apparatus. The opening in the meridian for making observations is three feet in width and is covered by three shutters, which are counterpoised in every position so that they may be opened and closed with ease.

The counterpoise for the meridian shutters is secured in the following manner which, so far as I know, is a novel device as applied to observatories. The support for the shutters is elevated eighteen inches above the level of the roof and the rear of the shutter projects a like amount. On the under side of this projection a sufficient weight of flat iron bars is bolted to nearly balance the weight of the shutter. On the under side of the shutter, in the observing room, a single knee-joint is attached at the middle of the shutters and by means of a rope fastened to the knee-joint, and passing over a pulley the shutter may be elevated. When the shutter is raised, the arms of the knee-joint are nearly in a straight line, and hence there is no leverage for a downward pull. In order to secure the necessary leverage, a hinged arm is attached to the side wall of the opening, being held nearly vertical by a small weight when the shutter is open. A rope is connected to the shutter and arm, allowing about two feet of slack between the shutter and arm. Now a downward pull on the rope throws the hinged arm nearly at right angles to the slit opening before the pull is applied to the shutter to close it. The ropes for opening and closing are wound in an eight-inch drum which is turned by an iron hand-wheel two feet in diameter. The slack in one of the ropes, due to the motion of the lever arm as above mentioned, is taken up by a spiral spring pulling at right-angles to the motion of the rope.

The shutters are wide and quite heavy, each requiring about four hundred and fifty pounds of iron to counterpoise, yet it requires only a few pounds of force on the hand-wheel to open and close them.

On the northeast side there is a suite of three rooms for the clocks, chronographs, and minor apparatus. On the northwest side are two rooms, each 15 × 16 feet, to be used for offices or computing rooms. Between the east and west suite of rooms before mentioned there is a large room, 21 × 30 feet, lighted from the north side, and fitted up for the library.

The north half of the building only is heated, the hall-way serving as a barrier to the heat entering the observing rooms. The tower for the great equatorial is circular in form and is thirty-seven feet in diameter on the outside. The walls are of stone and are carried up far enough so that when the telescope is pointed horizontally no portion of the building will obstruct the view. The top of the wall is surmounted by a layer of cut stone, twenty inches in width and ten inches in thickness, all fastened together to form a substantial bed for the dome.




GROUND PLAN OF THE NEW DEARBORN OBSERVATORY.

The observing room in the tower is reached by means of two flights of stairs.

The revolving dome is 34 feet in diameter in the clear and is constructed wholly of iron and steel. As there are some novel features pertaining to this dome, a brief description may be of interest. In the mounting of domes, the universal method has been to rest the dome on balls or wheels,

between tracks above and below; when wheels are used, they are usually set in a ring and two upper and two lower tracks, are employed. In recent years, however, Messrs Warner & Swasey, of Cleveland, have used one upper and two lower tracks, and the wheels are mounted in separate trucks, which are connected together. In our dome a single upper track is used, which rests on the tops of stationary wheels. There are sixteen of these wheels, sixteen inches in diameter, and the axles are supported on anti-friction cylindrical bearings, somewhat similar to a bicycle bearing. The method is very simple and also offers a number of advantages over any other method hitherto employed. The following are some of the principal advantages:

1. The lower double track is dispensed with.
2. The live ring is eliminated.
3. Each support and wheel are independent.
4. Any wheel may be removed for repairs or adjustment without disturbing the rest.
5. The dome may be leveled in a few minutes, should it become necessary from irregular settling of the wall.
6. Great stability of the dome.

The upper track is of cast iron, twelve inches wide and six inches deep, made in twenty sections. The surface in contact with the wheels is planed, as well as the inside, and the sections are bolted together to form a solid ring, the total weight of which is about three and one-half tons. There are no flanges on the wheels; the dome being kept in place laterally by inside anti-friction guide wheels, bolted to the wall. Each truck, for supporting the wheels, is held in place by two bolts inserted in the top of the wall, and the truck is also provided with four set screws for leveling up the wheel.

The superstructure is wholly of iron, the ribs are of wrought iron, and the covering is of numbers 20 and 22 galvanized iron-plate. The weight of the moving parts of the dome is about ten tons, and when in motion it requires a direct force of about twenty-five pounds to keep it going. It is rotated by a crank, with rack and pinion, the dome moving one-third the speed of the crank. The ease of rotation is all that could be desired, since the dome may be turned by one person through one revolution, or 115 feet, in

one minute. When started at the ordinary speed one would naturally use, it will travel from 6 to 10 feet by its own momentum. Although 16 wheels are used under the dome, it will revolve equally well when every alternate wheel is disconnected by lowering the truck.

The opening for observations is four feet in width, all in one place, and extends from the horizon to two feet beyond the zenith. We consider this arrangement of the opening of the greatest importance. Any one who has had experience in the use of a large equatorial will appreciate the convenience of a continuous opening.

The principle involved in the construction of the shutter, so far as I know, was first applied on the new Greenwich dome, viz., extending the shutter over the whole hemisphere. In the construction of our shutter we have, however, materially modified the Greenwich construction. The shutter is entirely disconnected from the superstructure, being supported at the base of the dome on a pivot on one side and a track on the other. Immediately after its erection it was found that there was some lateral sway to the shutter, especially during a high wind, and to cure this defect a second pivot was added about six feet above the base of the dome. This method of construction is found to give sufficient lateral rigidity to the shutter without interfering with its freedom of motion. The shutter runs on anti-friction wheels, and may be completely opened or closed in less than ten seconds with a direct pull of about ten pounds.

The method for opening and closing the dome shutter is as follows: On the inside of the dome is mounted a short shaft which carries a small drum and a V pulley. Wire ropes are attached to the shutter, and after passing over guide pulleys are wound on the drum. An endless rope, having a loose pulley and half pound weight at the lower end, hangs over the V pulley in the inside within three feet of the floor. Another cord is fastened to the spring bolt and also hangs within reach. The spring bolt is first unlocked, when, by pulling on the endless rope the shutter may be opened. By this arrangement there are no ropes to be looked after when revolving the dome, except when the endless rope is passing the crank.

Considering the dome as a whole, and taking into account its ease of rotation, combined with the convenience of the shutter, we believe it will rank among the best domes hitherto constructed.

The foundation of the equatorial pier is a bed of cement resting on clay at the depth of 15 feet below the surface of the ground. The pier is circular and is 15 feet in diameter at the bottom and 10 feet at the top. It is built of brick, hollow, with cross walls at right angles through the center, and is entirely disconnected from the building. The top of the brick column is covered with three stone slabs, nine inches in thickness, on which is placed the stone pier to which the great telescope is attached.

In mounting a Meridian Circle, it is desirable, if possible, to secure unchanging stability in the instrument. Any instrument which is liable to change in level or azimuth a number of seconds of arc, during a night's work, or from one day to another, leaves a suspicion of uncertainty in the accuracy of some of the observations. At the old site in Chicago, the Meridian Circle was mounted on brick piers, covered with wood. It was found to be greatly affected by temperature; the change in level and azimuth, between summer and winter, amounting to more than twenty seconds of arc. In the construction of our new pier it was decided to use stone, and at the suggestion of Dr. Cummings a cement or artificial stone pier was constructed. The foundation of this pier is three feet below the floor of the cellar. The pier is rectangular, 8 feet 5 inches in length, 5 feet in width, and about 10 feet in total length. On account of its great mass it will not readily be affected by sudden changes in the temperature. On the top of this base is laid a stone slab 8 feet in length, 4 feet in width, and 9 inches in thickness, on which rest two sandstone piers, each weighing about two and a half tons on which the meridian circle is mounted.

On the second floor of the building, besides the room in the tower, there is a large room the same size as the library, and two side rooms, one of which has been fitted up for photographic work. The interior of the building is finished throughout in hardwood; it is probably one of the most convenient and best constructed Observatory buildings in the United States.

## AN AUTOMATIC RIGHT ASCENSION CIRCLE.

LEWIS SWIFT.

For The Messenger.

The object of this device is to read, directly from the circle, the R. A. of an object already reduced to any desired epoch, regardless as to the month or year in which the observation was made, or of even the error of the sidereal clock, its *rate*, during the hours of observation only, entering as a function of discordance, all that is required of the clock being to make and break, once per second, the connection with a galvanic battery. Three kinds of clocks are employed, viz: the sidereal by Howard, standing in a niche in the north side of the pier in the dome-room, the driving-clock, and two which I shall name the vernier-clocks, one of which (see cut 1) is now both propelled and controlled in the usual manner; the other, cut (2), is *controlled* by a sounder connected electrically with the sidereal clock.

For several years I had used an arrangement constructed on similar principles as the one about to be described, attached to the north side of the pier just above the sidereal clock and on a level with the eye (an important consideration), but as it necessitated the use of a somewhat lengthy metallic cord braided of fine brass wires, connecting two equal sized pulleys, one on the polar axis of the telescope and its elasticity causing a slight error, it was abandoned as a measuring instrument a year since, though still employed for finding purposes. The present method was then substituted, and, for measuring, leaves nothing to be desired, though less convenient for finding as a short ladder has to be climbed.

The original has been more fully described and illustrated in "The History and Work of the Warner Observatory," Vol. I, a copy of which will be mailed to any reader desiring it, but as that is now devoted to finding purposes only, it becomes necessary to briefly explain its new use which an inspection of Fig. 1 will greatly assist.

On the east side of the pier, firmly screwed into its wooden casing, is a heavy bolt not seen in cut, projecting to such a distance that, when the brass head of the telescope tube touches it, the telescope is exactly in the meridian. This answers as a pretty accurate transit instrument. In fact, it

serves to correct the rate of the sidereal clock whose running is so satisfactory that it is seldom more than one or two seconds in error. Suppose it be desired to point the telescope on, say, 13 Messier (the cluster in Hercules), without

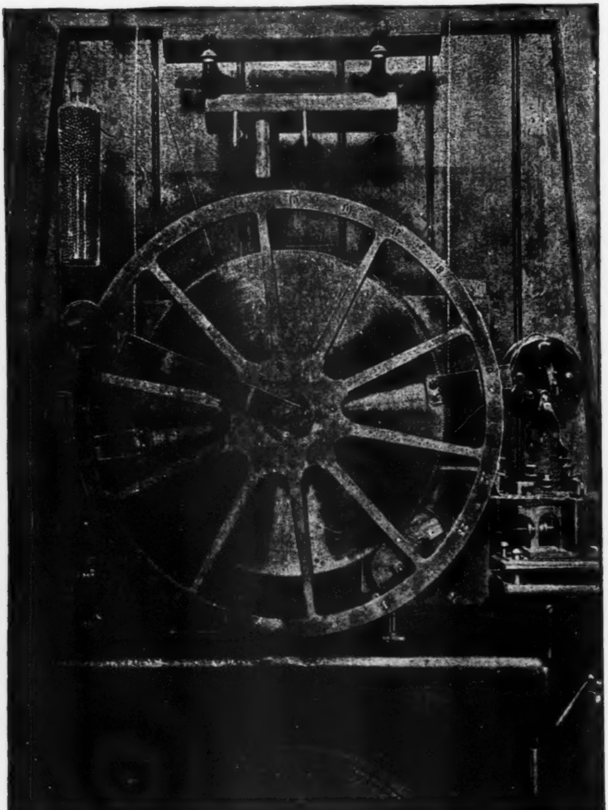


FIGURE 1.

the trouble of seeking a setting star, or of twice moving the dome, once for the star and again for the object to be observed. The telescope is brought into contact with the head of the bolt, the vernier set to the time as read from the clock face below which, if correct, is given, of course, the

R. A. of the meridian. Now the little clock is driving the vernier around the circle at the same rate that the stars are moving around the sky, and the hands around the dial face of the clock. For finding the object sought, it matters not what the R. A. of the meridian is; it is sufficient to know that the reading of the circle gives the R. A. of the place at which the telescope is pointing, technically called the line of collimation, which, if the vernier-clock keeps running, it will do. The R. A. of the cluster being 16*h* 37*m* 42*s*, the eye-end of the telescope is pushed too far out, and, with eye at the vernier, the telescope cord is gently pulled till the vernier reads its proper R. A., and when the telescope is moved to its declination the cluster will be fonnd in the center of the field.

Figure 1 shows the circle (15 inches in diameter) graduated to minutes of time, the verniers, the toothed wheel on the hour arbor of the vernier-clock, the sounder which *controls* the rate of the verniers, the weight (a bottle of shot) which propels them, the switch and the upper portion of the sidereal clock. Since, however, this was discarded for measuring, a common clock has been substituted for the control sounder, thus dispensing with an extra set of batteries.

DESCRIPTION OF THE IMPROVEMENT.

What has previously been said will greatly assist in understanding what is to follow. The Mosstype shows, though not as clearly as desired, the invention attached to the polar axis of the telescope, thus doing away with one source of error, the yielding of the metallic cord before alluded to. The hours on the circle are numbered from *east to west* consecutively from 0*h* to 23*h*; and also the zero of the verniers had to be shifted to likewise read in the same direction. The circle, 20 inches in diameter, is graduated to minutes of time, and reads by verniers to single seconds. It is loose on the polar axis in order to be revolved for setting to the R. A. of the setting star, preferably when on or near the meridian, for the elimination of refraction in R. A., but is firmly held in place by friction. Between the hours 16 and 17 is seen a vernier, and, directly opposite the other, both attached to the large gear (4) having 480 teeth cut around its circumference, into which a pinion with twenty teeth on the

hour arbor of the vernier-clock (2) engages, which causes the attached verniers to make a revolution in $480 \div 20 = 24$ sidereal hours. If, therefore, a meridional star be bisected by the meridional wire in the eye-piece, and the circle be revolved that one vernier shall read to the R. A. of the setting star for the selected epoch, the reading will constantly and accurately give the R. A. of the line of collimation, providing the vernier clock runs truly and the circle does not slip.

In front of the little clock is seen a sounder, to the vibrating bar of which is attached an arm connecting it with a pinwheel escapement of thirty pins to the vernier clock, one of which is released at each vibration of the armatue. A wooden wheel (5) is bolted to the vernier gear (4), around which a cord is wound, going over pulley (7) and others to a weight running down by the side of the driving clock weight. This is the propelling power of the verniers, the control being the electric sounder. The cord steadily pulling one way allows no play between the teeth. The little clock (called a double spring locomotive clock) is substantially built; the escapement, escapement wheel, and hair spring were removed, and the previously mentioned pinwheel substituted, and unless the sounder ceases to vibrate, will run as accurately as the sidereal clock itself with which it is electrically connected.

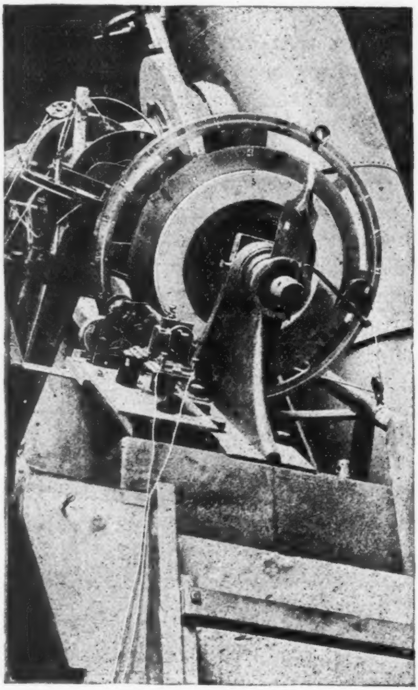


FIGURE 2.

To prepare for the night's work I proceed as follows: The driving is started, the telescope pointed to a mean time almanac star for 1890.0, say Arcturus (if I wish to work on a zone having a north declination of from 15° to 25°) whose R. A. for that epoch is 14*h* 10*m* 39*s*, and when it is accurately bisected by the meridional wire in the eye-piece, the circuit with the battery is closed by the switch, the ladder ascended and the circle revolved to read 14*h* 10*m* 39s, all of which requires but a moment.

The sounder is worked by a battery of three gravity cups. Formerly the break wheel in the sidereal clock had but 29 teeth, one of the 30 having been cut out to cause the circuit to be broken at the 58th second, which also necessitated the use of 29 pins in the escapement of the vernier clock, causing a slight error at the latter portion of each minute. This was corrected by replacing the cut-away tooth, and using an escapement of thirty pins.

I hope the above explanation and description will make the matter intelligible to the readers of THE SIDEREAL MESSENGER.

The celerity and accuracy with which the R. A. of a nebula can be obtained already reduced to any desired epoch, is surprising, saving a vast amount of valuable time which, in a cloudy country like this, cannot be overestimated.

WARNER OBSERVATORY, July 20, 1889.

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## THE SOLAR CYCLE.

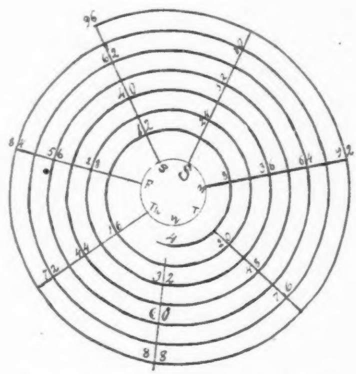
R. W. McFARLAND.

For THE MESSENGER.

The meaning intended to be conveyed by Herschel, in the extract referred to by Professor Swift, June MESSENGER, I would express in the following terms: "After a lapse of twenty-eight years the order of the days of the week and the days of the month will be the same," or, "in twenty-eight years all possible changes in the days of the week, as applied to any month, will have occurred, and then the same order will be repeated." And any day of any month must therefore come at least once on Sunday, or Monday, etc., in twenty-eight years:—for example, the twenty-ninth of

February occurs on Sunday only once in twenty-eight years. It occurs also once on each of the remaining days of the week.

The solar Cycle is the product of four, the interval from one leap year to the next, and seven the number of days in a week; and was made by the chronologists many centuries ago for the ecclesiastical calendar. Were it not for the extra day in leap year all possible variations of the days of the week, as related to any given day of the month, would take place in seven years. Everybody knows that ordinarily the year begins and ends on the same day of the week. It follows, as a matter of course, that the next year begins one day later in the week, but the year following leap year begins two days later, and it is this extra day which requires four times the cycle of seven in which to make all possible variations.



FEB. 29 OF THE NINETEENTH CENTURY.
[62 in the figure should be 68.]

The law of the succession can be very prettily shown in the following way: make a circle of any convenient size, mark the circumference off into seven divisions, as in the diagram. Set *Sunday* at the top, and the other days of the week in order towards the right. Extend the radii through the several divisions. Knowing that the 29th of February occurred on Wednesday in 1804, set the number four on the radius passing through Wednesday. Then, since in four years the first day of January, or any day of any month, goes forward five days of the week, the 29th will go from Wednesday to Monday. It amounts to the same thing to say that it goes backward *two* days, *i. e.*, from Wednesday to Monday. Each successive period of four years will show the like result. Beginning at Wednesday draw a left-handed spiral; on the Monday radius set 8 for the year 1808; pass-

ing again 2 to the left and the year 1812 is marked 12 on the Saturday radius, and so on for the century. But as 1900 is not a leap year we stop at 96.

The following facts are apparent on inspection:

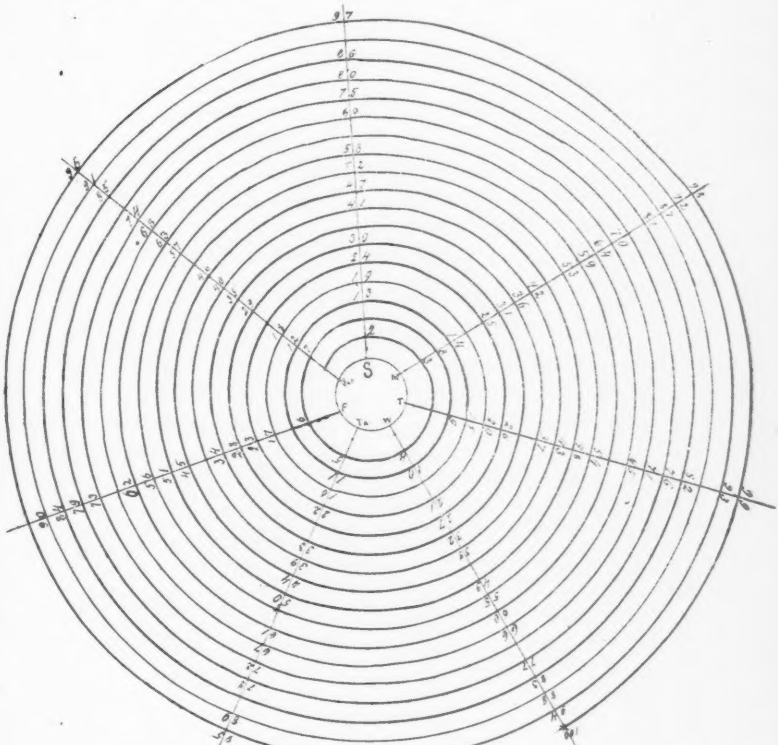


Diagram of the Fourth of July during the Century.

1st. That there is a lapse of twenty-eight years from the time the twenty-ninth falls on Sunday before it again falls on that day; and similarly for the other days.

2d. That the 29th of February falls 3 times on Sunday in this century, 4 times on Monday, 3 times on Tuesday, 4 times on Wednesday, 3 times on Thursday, 3 times on Friday, and 4 times on Saturday. The same thing will be repeated in the next century.

In like manner for any day of any year, say the 4th of July, make a circle and set in the days of the week as before; then as the 4th day of July was Saturday in 1801, mark 1* on the Saturday radius. In 1802 the 4th was on Sunday, place 2 on the Sunday radius; 3 on Monday, and 4 on Wednesday, because the 29th of February had pushed the day one further along in the week. I should have stated that the spiral should run in the same direction as the days of the week,—right-handed in this case. It will require 17 or 18 spires for the century. The cut on the preceding page shows the arrangement here suggested, and one notices that the 4th does not fall at intervals of 28 years strictly as does the 29th of February, but that at one time there is an interval of 11 years followed immediately by another of 6 years, then one of 5, then one of 6, the sum being 28, and then the 11 year period comes on again. The same rule holds for all the days of the common year of 365 days. Of course it is the mathematical relation existing between the natural numbers when arranged in spires of 7 spaces, and a skip is made once in 4. There is no mystery about it, and when the series of numbers is put down as here suggested, the whole order is patent on the simplest inspection.

It is further seen that 28 is the smallest number of years which will accomodate the 29th of February and the reason why 28 is the solar cycle is readily seen.

Oxford, Ohio, Aug. 1889.

## THE DOUBLE-STAR, 26 DRACONIS ($\beta$ 962)

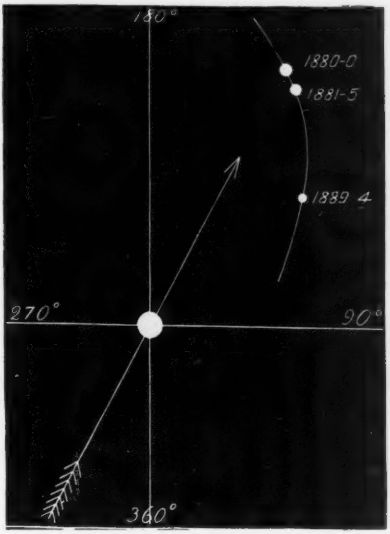
S. W. BURNHAM.

For The Messenger.

This star was discovered to be double with the 18½-inch refractor of the Dearborn Observatory. It seemed quite certain that it would prove to be an interesting physical pair from the fact of the large proper motion of the principal star. This is given by Argelander as 0″.582 in the direction of 152°.2. It was obvious, if the new component was fixed in space, or did not share this movement, that at any time more than half a dozen years before its discovery

* Omitted in cut by mistake of the engraver.

the two stars would have formed an easy pair which could not have well escaped detection. In 1881 I made another set of measures with the 15½-inch at the Washburn Observatory and this showed conclusively that both stars had the same proper motion, and also that there was some orbital motion. A recent set of measures here with the 36-inch shows a decided change in both angle and distance. It is now much more difficult and is likely to be soon beyond the reach of all ordinary telescopes.




STAR 26 DRACONIS (Scale 1′ to 1.25 in.).

If the stars were of nearly the same magnitude, there would be no difficulty in following the companion much nearer the primary with a moderate aperture, but as the large star is about 5½ magnitude and the other only 10 or 11, it makes a difficult pair when the distance is much under 1″. Apparently in two or three years more, it will test the power of the great telescope.

With the exception of a single observation at Cincinnati in 1879, the following are all the measures down to this time:

| | | | | |
|---|---|---|---|---|
| 1879.97 | 151°.8 | 1″.37 | β | 4*n* |
| 1881.53 | 148 .1 | 1 .31 | β | 3*n* |
| 1889.42 | 130 .1 | 0 .95 | β | 4*n* |

These measures are carefully platted to scale on the accompanying diagram. The direction of the proper motion is indicated by the arrow. It is desirable that measures be made of this pair by observers having sufficient optical power.

## MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.

For The Messenger.

The Astronomical Society of the Pacific met in the library of the Lick Observatory on July 27th, with a good attendance of members. It was announced that the report of the observations of the solar eclipse of last January, now being printed by order of the Regents of the State University, had reached page sixty, about one-third of the volume. It contains reports from more than 150 persons, distributed at twenty-five different observing stations. Hon. C. F. Crocker has offered to bear the expenses of an expedition from the Lick Observatory to Cayenne, South America, next December, and it is expected at that time to confirm and extend some of the discoveries made at the last eclipse. The announcement was also made that Hon. Joseph A. Donohoe of Menlo Park had founded a medal for the discovery of comets and had provided a permanent fund for the purpose. This gift was gratefully accepted by the Society.

There were too many papers presented to allow all of them to be read, and accordingly some were postponed till the next meeting. The papers read, either by title or in full, were: On the possibility of photographing the corona in full sunshine, by Mr. Keeler; on the orbit of the comet Barnard (June 23d), by Mr. Leuschner; on the occultations of Jupiter to be expected in 1889, by Mr. Hill; on a photograph of the Milky-Way near Jupiter, taken on the 24th inst., with one hour and forty-eight minutes exposure, by Mr. Barnard (this beautiful picture was exhibited to the meeting); on the real shape of the nebulæ in which we see a spiral, by Professor E. S. Holden. The latter paper was the longest one of the evening, and will be printed in the publications of the society in full. Its purpose is to show the real shape of the so called spiral nebulæ in the space of three dimensions as deduced from their apparent shape as projected in two dimensions on the background of the sky. This is a problem that has had no solution up to this time and it is one that has important bearings, not only on the question of the construction of the spiral nebulæ, but also upon the much larger question of the constitution of the solar system and of the universe as a whole.

The following persons were elected to active or life membership at the meeting: Ex-United States Senator James G. Fair, Robert D. Fry, Rudolph E. Voight, D. P. Belknap, Mrs. Wm. Alvord, Alexander Montgomery, Mrs. Alexander Montgomery, John Partridge, Dr. George C. Pardee, Miss Fidelia M. Jewett, Miss L. J. Martin, Lester L. Robinson, A. B. Forbes, John R. Spring, Judge John H. Boalt, Robert M. White, Horace L. Hill, Joseph G. Lavery, Dr. W. B. Leavitt, Dr. L. L. Dunbar, Charles Webb Howard, John Perry, Jr., Dr. M. J. Sullivan, Darius Ogden Mills, Captain Charles Goodall, Adam Grant, Joseph D. Grant, Arthur W. Foster, all of San Francisco, Cal.; Hon. Alfred L. Tubbs, J. McClymonds, Charles G. Yale, George N. Strong, ex-Governor George C. Perkins, J. C. Bullock, of Oakland, Cal.; Charles R. Tisdal, of Alameda, Cal.; Charles W. Friend, of Carson City, Nev.; C. H. Clement, of Livermore, Cal.; United States Senator John P. Jones, of Nevada; Henry B. Alvord, of San Jose, Cal.; and Senor Felipe Valle, Senor Manuel G. Prieta, Director Angel Anguino, Feodora Quintano, Camillo Gonzales, Francisco Rodrigues Rey, of the National Observatory at Tacubaya, Mexico.

After the adjournment of the society the members looked at the various objects of interest shown by the astronomers of the Observatory, and then a portion returned to the Smith Creek Hotel to sleep, while the rest, as many as possible, were entertained by the astronomers on the mountain. The affairs of the society are in a most prosperous condition owing to the great interest taken in its progress by the members. It is essentially a Society for amateurs, and desires to include in its membership every person in California who takes an interest in astronomy, whether he has made studies in this direction or not. Several ladies are already members. The dues are $5 per year, and there is no initiation fee. Life membership is $50. Its publications are sent to every member, and three of its six meetings are held in San Francisco. The scope of the society is defined so that it can have no possible rivalry with any other. Its sole object is to forward the study and the science of astronomy.

The medal offered by Hon. Joseph A. Donohoe of Menlo Park is to be given to the first discoverer of every unexpected comet and to the first person making a precise obser-

vation of a telescopic periodic comet at any one of its expected returns. This medal is intended solely as a recognition of merit and to commemorate the discovery, and is not designed in any sense as a reward. The astronomer's reward consists in the discovery itself. Mr. Donohoe also offered the gift of a fund sufficient to maintain such a medal in perpetuity from and after January 1, 1890. The Society will proceed to give practical effect to the offer by the establishment of the medal and by the fixing of the regulations for its bestowal. No application for the award of the medal is required. It will be given as a matter of course to the acknowledged discoverer of a new comet. It is, however, prescribed that a letter should be addressed to the director of the Lick Observatory, which communication must contain all the particulars of the first observation.

Such medals as this are given by various scientific societies and academies, both in America and abroad, and they serve as interesting and valued mementos to their possessors, as incentives to the younger generation of astronomers and a series of landmarks in the history of scientific progress. The full conditions on which the awards will be made will shortly be printed in the various scientific journals and the publications of the Astronomical Society of the Pacific, where they can be found by those interested.

LICK OBSERVATORY, July 28, 1889.

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## ON THE COMPANIONS TO COMET d 1889 (BROOKS).

E. E. BARNARD, ASTRONOMER.

Since the discovery of a group of companions to the great comet of 1882 [see *A. N.* 2489] I have been impressed with the idea that other comets may be attended by companions which, from their faintness, or from a failure to search for them, may escape discovery. I have therefore examined the immediate neighborhood of all comets since then in the hope of finding such companions.

The 12-inch telescope being out of order, it was not possible to observe Brook's comet with it after the July moon until the night of August 1, when I observed the comet for position. While examining the region about the head of the

comet on this date, I detected two small nebulous bodies following the head, but preceding the comet in space. The nearest of these was suspected to be a companion; its distance and position-angle were therefore measured from the nucleus. The second morning showed that both objects were moving with the comet, and therefore were companions. These objects I have named *B* and *C*.

On Aug. 3, these were examined with the 36-inch equatorial, which showed the whole group very beautifully. Each of the companions had a very small nucleus and condensation in a very small head, and a short, faint tail, presenting a perfect miniature of the larger one, which was pretty bright and well developed, with small nucleus and slightly fan-shaped tail ¼° long. There was then absolutely no nebulous connection with the larger, nor has there been at any time since, either in the 12-inch or in the 36-inch telescope. Nothing whatever has been seen here of the nebulous envelope spoken of by the Vienna observers as apparently enclosing the whole group [A. N. 2914]. I have from the first carefully looked for a nebulous connection. Under unfavorable circumstances the tails of *B* and *C* might be imagined to be a connecting nebulosity, but the tail of *B* falls short of A and that of *C* does not nearly reach *B*. Each comet is in appearance absolutely independent of the other. The tails of all three have lain in the line of the nucleus of *A*, and therefore have not sensibly deviated from the position-angle 241.°

On August 4 two other companions were detected with the great telescope, one of which was measured, the other being too elusive to place the wires on. I have numbered these four companions *B*, *C*, *D*, *E*, in the order of increasing right ascension, *A* being the larger comet, *D* and *E* being the two last discovered. The position of *D* Aug. 4, referred to *C* was: distance, $78''.18$; P.A., $23^\circ.3$. *D* has been seen several times since the moon withdrew, but has always been too faint to observe; it has not sensibly changed its position. *E* has only been seen once; its position-angle referred to *C* would be the same as that of *D*, and its distance twice as great. Four or five other nebulous bodies observed near the comet Aug. 2 have not since been seen, and were probably nebulous.

The results of the observations of the two brighter companions are extremely interesting. Measures of *B* have been made on eighteen and of *C* on seventeen nights. These two have almost exactly the same position-angles, which have been sensibly constant; their distances from the main body have, however, been increasing. At the last few observations *B* seems to be stationary, the distance from *A* remaining constant, while *C* continues to recede. The following from my measurements will give some idea of these changes.

From Aug. 1 to Aug. 5 *B* was separating from *A* at the mean rate 0″.93 per day, while from Aug. 16 to Aug. 24 this was reduced to 0″.20, or essentially zero.

From Aug. 2 to Aug. 5 *C* was receding 1″.72 per day, and from Aug. 16 to Aug. 24 this had increased to 2″.76.

From Aug. 1 to Aug. 5 the mean position-angle *AB* was 59°.92, and from Aug. 16 to 24 it was 61°.27.

Aug. 3 to Aug. 5 the mean position-angle *AC* was 61°.43; and from Aug. 16 to Aug. 24, 61°.68. At first the position-angle *AB* was sensibly less than *AC*. They now appear to be on the same line with the nucleus.

Following are the positions of the two companions with reference to the nucleus *A* on two of the dates of observation:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aug. | 3 | *AB* | 66″.48 | 59°.9 | : | *AC* | 263″.46 | 61°.4 |
| " | 28 | *AB* | 73 .22 | 63 .2 | : | *AC* | 328 .44 | 61 .6 |

I have measured these objects every night, except when the moon interfered, and have been struck with the rather sudden change in the appearance of *B*. At first very small with ill-defined nucleus, and a tail nearly 1′ long, it was comparatively an easy object to measure in the 12-inch. It has steadily become more difficult, even in the great telescope, and at the last few observations has become extremely difficult, ceasing to be visible in the 12-inch; the central condensation has disappeared almost entirely, and the nebulosity become much larger, fainter and more diffused, making it almost impossible to bisect it accurately. In the mean time *C* has become easier, perceptibly brightening, and the central condensation more marked.

Since August 2, the observations have been made with the 36-inch equatorial.

In hopes that it may be possible to determine the mass of this cometary system, I have made careful micrometric measures on every night possible, and these measures will be kept up as long as the companions can be seen.—*Astronomical Journal* No. 202.

MT. HAMILTON, Aug. 29, 1889.

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## COMET BROOKS (d 1889).

WILLIAM R. BROOKS.

FOR THE MESSENGER.

Clouds and moonlight prevented observations of the new comet discovered by me on July 6, from July 9th to July 21st, but on the latter date I set the 10-inch equatorial to the place I had computed the comet to be from its rate and direction of motion, and had it at once in the field. The approximate place was July 21, 13 hours; R. A. 23*h* 57*m* 50*s*; decl. south 7°48′. I found the comet considerably brighter than at discovery. The tail was more conspicuous, and at the extreme front of the head was a stellar nucleus.

July 23.—The apparent motion is exceedingly slow, the place of the comet this morning at 14 hours being R. A. 23*h* 59*m* 20*s*; decl. south 7° 38′.

The comet is brighter, and the tail broader and longer.

Aug. 7.—Good view of the comet this morning, the air being much clearer than for some time past. The nucleus is elongated in a line with the axis of tail. I see distinctly one of the fragments reported by Barnard, thrown off from the comet, just in front of the head. It has also a very faint tail. I also suspect another just below the first. But considerably larger and more distinct than the latter, I see another fragment which has evidently drifted backwards over the tail of the main comet, and is now near the end of the same as if immersed in it.

Aug. 28.—The comet at midnight is in R. A. 0*h* 6*m*; decl. south 5° 59′. How slow it moves! Nearly two months since the discovery, and yet it is only four wide fields distant from the place of discovery. The brightness is about the same as at last observation, and the comet does not appear to have lost anything by the companions it has thrown off.

Dr. K. Zelbe in *Astro. Nach.* has computed elliptical elements with a period of 12⅓ years. Mr. Chandler in his first elements suggested its probable short-period character.

SMITH OBSERVATORY, Geneva, N. Y., Sept. 10, 1889.

## CURRENT INTERESTING CELESTIAL PHENOMENA.

### THE PLANETS.

*Mercury* will be at inferior conjunction with the sun Oct. 15, being then a degree and a half south of the sun, so that no transit will occur. During the greater part of the month he will be too near the sun for favorable observation. On the morning of Oct. 31 he will be at greatest elongation, 18° 43′ west from the sun, rising an hour and a half earlier than the latter. Three days later Mercury and Uranus will be in conjunction, the distance between them being 1°45′, coming within the diameter of field of an ordinary finder. Here will be a good opportunity to compare the colors and relative brightness of the two planets.


RELATIVE POSITIONS OF VENUS, MERCURY, URANUS AND SPICA (Scale 2°38′ to 1 in.

*Venus*, having passed the conjunction with Saturn and Mars in Leo near Regulus, proceeds eastward through Leo, entering Virgo Oct. 14, passing close to the stars $\beta$, $\eta$, $\gamma$, and $\delta$ of the latter constellation, and coming to conjunction with Uranus Nov. 9, at 1 P. M. On the mornings of Nov. 2, 3, and 4, the planets Venus, Mercury and Uranus will form an interesting group with the brilliant star Spica. About nine-tenths of the disc of Venus is illuminated, and its brilliancy is about one-third of that which it had in March of this year.

*Mars* follows Venus, but at a slower pace, from Leo into Virgo, and may easily be found in the morning a little higher up than Venus, almost on a line between Venus and Regulus. Recent numbers of *L'Astronomie* contain an extensive article by the editor, C. Flammarion, on "Changes Actually Observed on Mars." The author illustrates the article by a large number of well engraved and presumably accurate copies of drawings by various observers from Huyghens, 1659, to Schiaparelli, 1888. For this collection of drawings the article is an extremely valuable one, although we may doubt somewhat the accuracy of the drawings themselves, and so, in some particulars, the conclusions which the author draws from them. The conclusions are as follows:

1. "There are on the globe of Mars permanent spots which must represent seas, lakes, streams, marshes, etc.

2. "These spots are permanent; they are seen in our time in the same places where they were observed in the seventeenth and eighteenth centuries.

3. "However, while on the whole permanent, they are not invariable. They change in extent, form and hue, following the years and doubtless the seasons.

4. "There are some regions particularly variable, which appear to hold an intermediate position between continents and seas, like marshes alternately uncovered and submerged by a shallow sheet of water.

5. "The continents of Mars appear flat, and liable in almost all parts to encroachments of the water and inundations.

6. "The northern hemisphere is more elevated than the southern. The seas belong largely to the southern hemisphere; they do not appear to be deep.

7. "Evaporation is without doubt considerable and rapid. Millions of cubic meters of water pass easily from the vaporous to the liquid state, and thousands of square kilometers change from a continental to a maritime aspect.

8. "Not only water, perhaps, comes into play. There is an entirely different order of things from that which exists upon our planet."

The author commenting upon these says: "*We have only our terrestrial observations and ideas with which to explain things not terrestrial*, and the study of Mars is one of those which show us best that we are far from knowing all, that our planet is not the absolute type of the universe and that the other worlds differ from that which we inhabit. It is absolutely certain that this world is not inactive, sterile, dead, but, on the contrary, animated with life intense and prodigious, in comparison with which the normal aspect of the earth, seen from that distance, would seem lethargic tranquility."

*Jupiter* is getting too low in the southwest for good observations in the evening. Indeed its altitude has been so low when on the meridian that very few good observations have been obtained at Northfield this summer. The red spot has been distinctly visible only once; however, we must say that very little attention has been paid to the object here. Jupiter will be in conjunction with the moon Oct. 28 at 5 P. M. central time, and, as seen by observers in latitudes from 20° north to 30° south, will suffer occultation. The occultation on the night of Sept. 3 was observed at many places. At Carleton College Observatory the weather was cloudy, but a break in the clouds occurred just before the beginning of the occultation, and another at the end, which permitted the following observations to be made:

| | Local Mean Time. d | h | m |
|---|---|---|---|
| First contact; Jupiter's limb perceptibly notched | 8 | 00 | 00.3 |
| Jupiter's disk half covered | 8 | 00 | 48.8 |
| Second contact; Jupiter's disk wholly covered | 8 | 01 | 39.0 |
| Satellite I disappeared | 8 | 02 | 56.0 |
| Jupiter's disk half uncovered | 9 | 10 | 42.9 |
| Fourth contact; very poor definition | 9 | 11 | 46.1 |

The second of these times was difficult to note because of a large mountain on the moon's limb where it was projected upon the planet's disk, rendering the estimate of bisection of the latter doubtful.

At the reappearance the sky was in a still worse condition, a thick haze being behind the clouds. The satellites were invisible and the planet was not detected until nearly half the disk had emerged. The difference in brilliancy of the planet and the bright limb of the moon was very striking.

The observations were made by Dr. H. C. Wilson with the 8-inch refractor, magnifying power 95; times recorded upon chronograph.

*Saturn* is in good position for morning observation, and will soon be seen at midnight. He is in Leo, a little east of Regulus. Nothing of importance has recently come to hand concerning this planet.

*Uranus* is about 2° northeast of Spica, in Virgo. The conjunction with Mercury has already been spoken of.

*Neptune* is about one-third of the way from Aldebaran to the Pleiades, and may be seen during the whole of the night.

*The Sun* has not lately been as free from spots as it was during the first half of the year. During August spots were observed on sixteen days, four different groups being noted. On four days, Aug. 21 to 24, the disk was entirely free from spots. A large single spot, surrounded by many brilliant faculæ, was seen on the east limb Aug. 27, and was followed across the disk until Sept. 7. On that date two new spots of considerable size had been formed close to the old one. Sept. 9, 10, 12 and 16 no spots were visible.

MERCURY.

| | R. A. | Decl. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|
| | h m | ° ′ | h m | h m | h m |
| Oct. 15 | 13 23.5 | −10 25 | 6 24 A.M. | 11 45.7 A.M. | 5 08 P.M. |
| 25 | 13 02.1 | − 5 01 | 5 01 " | 10 45.0 " | 4 29 " |
| Nov. 5 | 13 39.2 | − 8 01 | 5 07 " | 10 38.9 " | 4 10 " |
| 15 | 14 35.9 | −13 51 | 5 48 " | 10 56.1 " | 4 04 " |

VENUS.

| | R. A. | Decl. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|
| Oct. 15 | 11 34.6 | + 4 17 | 3 37 A.M. | 9 57.0 A.M. | 4 17 P.M. |
| 25 | 12 20.0 | + 0 03 | 4 00 " | 10 03.1 " | 4 07 " |
| Nov. 5 | 13 10.4 | − 5 41 | 4 29 " | 10 10.2 " | 3 51 " |
| 15 | 13 57.1 | −10 19 | 4 55 " | 10 17.3 " | 3 39 " |

MARS.

| | R. A. | Decl. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|
| Oct. 15 | 11 02.7 | + 7 34 | 2 52 A.M. | 9 25.4 A.M. | 3 59 P.M. |
| 25 | 11 25.5 | + 5 11 | 2 45 " | 9 08.9 " | 3 33 " |
| Nov. 5 | 11 50.3 | + 2 33 | 2 35 " | 8 48.6 " | 3 02 " |
| 15 | 12 12.6 | + 0 10 | 2 29 " | 8 33.2 " | 2 37 " |

JUPITER.

| | R. A. | Decl. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|
| Oct. 15 | 18 10.3 | −23 30 | 12 08 P.M. | 4 31.8 P.M. | 8 56 P.M. |
| 25 | 18 16.9 | −23 29 | 11 35 A.M. | 3 59.1 " | 8 23 " |
| Nov. 5 | 18 25.4 | −23 26 | 11 01 " | 3 24.2 " | 7 47 " |
| 15 | 18 33.7 | −23 21 | 10 29 " | 2 53.1 " | 7 17 " |

| Date | R. A. h m | Decl. ° ′ | Rises. h m | Transits. h m | Sets. h m |
|---|---|---|---|---|---|
| | | | SATURN. | | |
| Oct. 15 | 10 13.4 | +12 23 | 1 43 A.M. | 8 36.3 A.M. | 3 30 P.M. |
| 25 | 10 16.9 | +12 06 | 1 08 " | 8 00.3 " | 2 52 " |
| Nov. 5 | 10 20.1 | +11 50 | 10 29 " | 7 20.3 " | 2 11 " |
| 15 | 10 22.4 | +11 39 | 11 53 P.M. | 6 43.3 " | 1 34 " |
| | | | URANUS. | | |
| Oct. 15 | 13 23.6 | − 8 10 | 6 15 A.M. | 11 45.9 A.M. | 5 17 P.M. |
| 25 | 13 26.0 | − 8 25 | 5 39 " | 11 08.9 " | 4 39 " |
| Nov. 5 | 13 28.5 | − 8 40 | 4 59 " | 10 28.2 " | 3 57 " |
| 15 | 13 30.7 | − 8 53 | 4 23 " | 9 51.0 " | 3 19 " |
| | | | NEPTUNE. | | |
| Oct. 15 | 4 10.1 | +19 20 | 7 09 P.M. | 2 33.8 A.M. | 9 58 A.M. |
| 25 | 4 09.2 | +19 18 | 6 29 " | 1 53.6 " | 9 18 " |
| Nov. 5 | 4 08.1 | +19 14 | 5 45 " | 1 09.2 " | 8 39 " |
| 15 | 4 07.0 | +19 11 | 5 05 " | 12 28.8 " | 7 52 " |
| | | | THE SUN. | | |
| Oct. 15 | 13 23.6 | − 8 48 | 6 17 A.M. | 11 45.7 A.M. | 5 14 P.M. |
| 25 | 14 01.4 | −12 22 | 6 29 " | 11 43.1 " | 4 57 " |
| Nov. 5 | 14 44.4 | −15 55 | 6 45 " | 11 43.7 " | 4 42 " |
| 15 | 15 24.9 | −18 42 | 6 59 " | 11 44.8 " | 4 31 " |

## Occultations Visible at Washington.

| Date. | Star's Name. | Magnitude. | IMMERSION. Wash. Mean T. h m | IMMERSION. Angle f'm N. P't. ° | EMERSION. Wash. Mean T. h m | EMERSION. Angle f'm N. P't. ° | Duration. h m |
|---|---|---|---|---|---|---|---|
| Oct. 14 | $\eta$ Geminorum | 3½ | 9 06 | 54 | 9 55 | 284 | 0 49 |
| 14 | $\mu$ Geminorum | 3 | 13 25 | 168 | Star 1.2′ S. of moon's limb | | |
| 16 | 7 Cancri | 6½ | 12 16 | 358 | Star 0.0′ N. of moon's limb | | |
| 16 | $\mu^2$ Cancri | 5½ | 14 15 | 176 | 14 20 | 184 | 0 05 |
| 29 | $\chi^3$ Sagitarii | 5½ | 4 47 | 61 | 6 03 | 286 | 1 16 |
| Nov. 1 | 56 Aquarii | 6½ | 10 06 | 57 | 11 15 | 244 | 1 09 |
| 3 | 33 Piscium | 4½ | 4 46 | 34 | 5 47 | 274 | 1 01 |
| 3 | B. A. C. 17 | 6 | 7 51 | 77 | 9 07 | 215 | 1 17 |
| 8 | $\epsilon$ Tauri | 3½ | 17 36 | 70 | 18 40 | 273 | 1 04 |
| 10 | 141 Tauri | 6½ | 10 58 | 135 | 11 36 | 194 | 0 39 |
| 10 | 3 Geminorum | 6½ | 16 40 | 32 | 17 24 | 329 | 0 45 |
| 10 | 6 Geminorum | 6½ | 18 01 | 86 | 19 16 | 281 | 1 15 |
| 12 | 84 Geminorum | 6½ | 15 59 | 150 | 16 59 | 228 | 1 00 |

## Phases of the Moon.

| | Central Time. d h m |
|---|---|
| Full Moon | Oct. 8 7 26 P. M. |
| Last Quarter | " 16 6 38 " |
| New Moon | " 24 8 26 A. M. |
| First Quarter | " 31 2 30 " |
| Full Moon | Nov. 7 10 05 " |

## Approximate Times of the Transit of the Great Red Spot Across the Middle of Jupiter's Disc.

| | h m | | h m | | h m |
|---|---|---|---|---|---|
| Oct. 6 | 10 31 P. M. | Oct. 11 | 9 41 P. M. | Oct. 16 | 8 51 P. M. |
| " 7 | 6 23 " | " 12 | 5 33 " | " 17 | 4 43 " |
| " 9 | 8 02 " | " 14 | 7 12 " | " 19 | 6 22 " |
| " 10 | 3 54 " | " 15 | 3 04 " | " 21 | 8 01 " |

**Phenomena of Jupiter's Satellites.**

| | Central Time. d | h | m | | | | | Central Time. d | h | m | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct. | 6 | 5 | 46 | P. M. | II | Ec. Re. | Oct. | 22 | 5 | 47 | P. M. | II | Sh. Eg. |
| | 6 | 7 | 48 | " | I | Ec. Re. | | 22 | 6 | 07 | " | I | Ec. Re. |
| | 11 | 5 | 40 | " | III | Oc. Re. | | 29 | 5 | 32 | " | III | Sh. In. |
| | 11 | 7 | 42 | " | III | Ec. Dis. | | 29 | 5 | 37 | " | II | Sh. In. |
| | 13 | 6 | 14 | " | I | Ec. Dis. | | 29 | 6 | 06 | " | II | Tr. Eg. |
| | 14 | 7 | 59 | " | I | Sh. Eg. | | 30 | 5 | 18 | " | I | Sh. Eg. |
| | 18 | 6 | 50 | " | III | Oc. Dis. | Nov. | 5 | 5 | 28 | " | III | Tr. In. |
| | 20 | 5 | 54 | " | II | Oc. Dis. | | 5 | 6 | 07 | " | II | Tr. In. |
| | 21 | 5 | 26 | " | I | Tr. In. | | 5 | 6 | 40 | " | I | Oc. Dis. |
| | 21 | 6 | 36 | " | I | Sh. In. | | 6 | 6 | 13 | " | I | Tr. Eg. |

*New Minor Planets, 285, 286 and 287.* A planet of the 13th magnitude or fainter was discovered by Palisa, Aug. 3.4972 G. M. T. in R. A. *22h* 13*m* 54.6*s*; decl. south 9°01′23″. Another was discovered by Charlois, at Nice, Aug. 3.4917 G. M. T., R. A. 21*h* 23*m* 24.5*s*; decl. south 13°04′22″. The third was discovered by Dr. Peters, at Clinton, N. Y., Aug. 25.5589, R. A. 22*h* 15*m* 17.5*s*; decl. south 14°03′00″.

**The Occultation of Jupiter on Sept. 3.**

Several have sent us very enthusiastic accounts of the occultation but giving only approximate times and no longitudes or latitudes of the places of observation, so that we cannot notice them here. Professor William Brooks, of Smith Observatory, Geneva, N. Y., writes as follows:

"The occultation of Jupiter on the evening of Sept. 3 was well observed here with the 10-inch equatorial and the 3-inch finder attached thereto. The latter was used after the photographic corrector and plate-holder had been attached to the larger telescope.

"The first contact with the moon's dark limb at immersion was noted at 20*h* 29*m* 21*s* local sidereal time; and the re-appearance of the planet from the moon's bright limb was recorded at 21*h* 25*m* 30*s*. The conditions were decidedly unfavorable for photographic work, the air being very smoky, which made the moon's color a deep orange. However I succeeded in obtaining several good negatives of Jupiter and the moon previous to occultation. Also one negative, and this I had set my heart upon, showing the planet when it was half covered by the dark limb of the moon. The motion of the moon in its gradual approach to

the planet is shown in an interesting manner in the series of photographs. And the record is autographic and permanent."

Mr. George A. Hill, at Washington, D. C., observed the first contact at 9*h* 41*m* 39*s*, and the second contact at 9*h* 43*m* 30*s* Washington mean time. The first of these observations was made through thick clouds, but the second was good.

Mr. J. W. Thompson, at Salem, Ohio, observed all four contacts with a four-inch telescope.

| | h | m | s | |
|---|---|---|---|---|
| First contact, | 8 | 39 | 00 | railroad central time. |
| Second " | 8 | 40 | 30 | " " " |
| Third " | 9 | 37 | 25 | " " " |
| Fourth " | 9 | 38 | 48 | " " " |

Mr. H. S. Hulbert, at Lansing, Mich., says that the time of the passage of the moon's edge off the disk of Jupiter was 1*m* 12*s*, "which greatly surprised" him.

## COMET NOTES.

*Comet e* 1888 (Barnard, Sept. 1, 1888) will be in very favorable position for observation in the evening during October, but its light is becoming so feeble as to make it a difficult object. The following ephemeris by C. W. Crockett is taken from *A. J.* No. 195:

| 1889 G. M. T. | App. $\alpha$ h m s | App. $\delta$ ° ′ ″ | log. *r* | log. $\Delta$ | Br. |
|---|---|---|---|---|---|
| Oct. 2.5 | 18 15 03.0 | −10 43 28 | 0.53349 | 0.52800 | 0.4 |
| 6.5 | 14 02.8 | 10 57 14 | 0.53805 | 0.54216 | 0.4 |
| 10.5 | 13 23.9 | 11 09 51 | 0.54256 | 0.55574 | 0.3 |
| 14.5 | 13 04.2 | 11 21 22 | 0.54704 | 0.56873 | 0.3 |
| 18.5 | 13 01.8 | 11 31 53 | 0.55147 | 0.58115 | 0.3 |
| 22.5 | 13 14.9 | 11 41 25 | 0.55585 | 0.59298 | 0.3 |
| 26.5 | 13 42.2 | 11 49 59 | 0.56018 | 0.60424 | 0.3 |
| 30.5 | 18 14 22.1 | −11 57 40 | 0.56448 | 0.61494 | 0.2 |

*Comet b* 1889 (Barnard, March 31) may be seen during the whole night. It is increasing in brightness, reaching the maximum about Oct. 8, but will not be visible to the naked eye. It is moving southwest through the constellation Eridanus, the River, toward the second star in $\beta$ Ceti. Oct. 10 it will pass very close to the star $\eta$ Eridani. We have no ephemeris at hand later than the following by W. W. Campbell (*A. J.* No. 201):

| 1889 G. M. T. | | App. $\alpha$ | App. $\delta$ | log. $r$ | log. $\Delta$ | Br. |
|---|---|---|---|---|---|---|
| | | h m s | ° ′ | | | |
| Oct. | 1.5 | 3 23 22 | − 5 48.9 | 0.4171 | 0.2541 | 1.70 |
| | 3.5 | 3 16 28 | 6 34.8 | | | |
| | 5.5 | 3 09 23 | 7 20.5 | 0.4208 | 0.2483 | 1.70 |
| | 7.5 | 3 02 07 | 8 05.9 | | | |
| | 9.5 | 2 54 41 | 8 50.6 | 0.4245 | 0.2451 | 1.71 |
| | 11.5 | 2 47 07 | 9 34.4 | | | |
| | 13.5 | 2 39 28 | 10 17.0 | 0.4283 | 0.2449 | 1.68 |
| | 15.5 | 2 31 45 | 10 58.1 | | | |
| | 17.5 | 2 23 59 | 11 37.5 | 0.4321 | 0.2477 | 1.63 |
| | 19.5 | 2 16 14 | 12 15.0 | | | |
| | 21.5 | 2 08 32 | −12 50.3 | 0.4360 | 0.2534 | 1.56 |

*Comet c* 1889 (Barnard, June 23) has passed beyond the reach of the most powerful telescopes. The latest reported observation was on Aug. 5.

*Comet d* 1889 (Brooks July 6) was found, by Barnard at Lick Observatory, Aug. 1, to be divided into three parts. This discovery was verified on subsequent nights and was communicated by telegraph to other observatories. Elsewhere will be found a communication from Mr. Barnard to the *Astronomical Journal*, and another from Mr. Brooks on the same subject.

Elliptic elements of this comet have been computed by Dr. K. Zelbr (*A. N.* 2918), Rev. George M. Searle and Mr. S. C. Chandler (*A. J.* 202), and Dr. O. Knopf (*A. N.* 2921), the first deriving a period of 12⅓ years, the second 8.34 years, the third 8.186 years, and the last 7⅓ years. The second and third results, while agreeing well, are not, however, independent, as the first and last observations used in the two computations were identical, July 8 and Aug. 19. The following elements and ephemeris are by Mr. Chandler:

$$T = 1889 \text{ Sept. } 15.3618 \text{ G. M. T.}$$

$$\left.\begin{aligned} \omega &= 335^\circ\ 50'\ 42'' \\ \Omega &= \phantom{0}19\ \ 15\ \ 08 \\ i &= \phantom{00}6\ \ 00\ \ 10 \end{aligned}\right\} 1889.0$$

$$\log q = 0.300652 \qquad q = 1.99826$$

$$\varepsilon = 0.507112$$

$$\text{Period} = 8.186 \text{ years.}$$

| 1889 G. M. T. | | App. $\alpha$ | App. $\delta$ | log $r$ | log $\Delta$ | Br. |
|---|---|---|---|---|---|---|
| | | h m s | ° ′ | | | |
| Oct. | 2.5 | 23 47 49 | −5 01.8 | | | |
| | 4.5 | 46 50 | 4 56.0 | 0.3021 | 0.0122 | 2.15 |
| | 6.5 | 45 54 | 4 49.6 | | | |
| | 8.5 | 45 04 | 4 42.8 | 0.3028 | 0.0193 | 2.08 |
| | 10.5 | 44 18 | 4 35.4 | | | |
| | 12.5 | 43 38 | 4 27.5 | 0.3036 | 0.0276 | 1.99 |
| | 14.5 | 43 04 | 4 19.2 | | | |
| | 16.5 | 23 42 36 | −4 10.2 | 0.3046 | 0.0371 | 1.90 |

*Comet e* 1889 (Davidson, July 21) was observed by Barnard on the evening of July 26 in R. A. 13*h* 30*m*, decl. south 22° 01′ in the constellation of Hydra. It has moved rapidly northeast, and may now be found in the middle of Hercules. Its brightness is however diminishing rapidly so that it will be a difficult object for small telescopes. The orbit is probably parabolic. The latest elements are by Professor T. H. Safford (*A. J.* 202) depending upon observations at Rome July 26 and Washington Aug. 7 and Aug. 16.

$$
\begin{aligned}
T &= 1889 \text{ July } 19.3066 \text{ G. M. T.} \\
\left.\begin{aligned}
\omega &= 345^\circ\ 53'\ 59.0'' \\
\Omega &= 286\ \ 08\ \ 21.3 \\
i &= \ \ 65\ \ 59\ \ 16.4
\end{aligned}\right\} & \ 1889.0 \\
\log q &= 0.016959 \\
q &= 1.03982
\end{aligned}
$$

The following ephemeris was computed by Mr. William Bellamy from elements quite similar to the above (*A. J.* 201):

| 1889 G. M. T. | App. α h | m | s | App. δ ° | ′ | log r | log Δ | Br. |
|---|---|---|---|---|---|---|---|---|
| Oct. 2.5 | 17 | 19 | 56 | +32 | 31 | 0.2033 | 0.1782 | 0.024 |
| 4.5 | | 23 | 43 | 32 | 46 | 0.2095 | 0.1876 | |
| 6.5 | | 27 | 31 | 33 | 01 | 0.2156 | 0.1967 | .021 |
| 8.5 | | 31 | 19 | 33 | 15 | 0.2216 | 0.2055 | |
| 10.5 | | 35 | 09 | 33 | 29 | 0.2276 | 0.2141 | .019 |
| 12.5 | | 38 | 59 | 33 | 43 | 0.2335 | 0.2224 | |
| 14.5 | | 42 | 50 | 33 | 56 | 0.2394 | 0.2305 | .017 |
| 16.5 | | 46 | 43 | 34 | 09 | 0.2452 | 0.2384 | |
| 18.5 | | 50 | 36 | 34 | 22 | 0.2510 | 0.2460 | .014 |
| 20.5 | | 54 | 31 | 34 | 35 | 0.2567 | 0.2535 | |
| 22.5 | 17 | 58 | 27 | 34 | 47 | 0.2623 | 0.2608 | .013 |
| 24.5 | 18 | 02 | 24 | 34 | 59 | 0.2679 | 0.2680 | |
| 26.5 | | 06 | 23 | 35 | 12 | 0.2734 | 0.2750 | .011 |
| 28.5 | | 10 | 24 | 35 | 24 | 0.2789 | 0.2818 | |
| 30.5 | 18 | 14 | 26 | +35 | 37 | 0.2843 | 0.2885 | .010 |

*Warner Prizes for Cometary Discoveries.* We are sorry to learn from Mr. Denning's comet notes in the September number of *The Observatory* that the money prizes offered by Mr. H. H. Warner, founder of the Warner Observatory, Rochester, N. Y., expired on May 1st last, and will not be renewed during the present year. These prizes were first offered in 1881, and the amount was then fixed at $200 to be paid to each discoverer of an unexpected comet. This sum was reduced in 1886 to $100 for each new comet. The greater number of these prizes have been won by Messrs. Barnard and Brooks, the two American observers who have been

most zealous in their search of the heavens, but there is chance for others, and we hope that the zeal of young amateurs will not be diminished because of the lack of a monetary consideration. It is gratifying to know that the prizes will probably be offered again next year. We take pleasure, also in this connection, in calling attention to the medals which are to be offered next year by the Astronomical Society of the Pacific (see page 360).

*Brilliant Meteors.* Tuesday, Aug. 27, a very brilliant meteor was seen in the eastern heavens. It started near the great nebula in Andromeda, pursuing a southerly course, and bursting near the center of the square of Pegasus. It was of an intense white color and somewhat more brilliant than an electric light. A few minutes later a second one started from the same constellation. It was about double the size of the first, and changed to an intense red, then to blue, finally bursting with a slight report. The pieces fell like sparks from a sky-rocket. It was a very beautiful sight, the finest I ever saw. W. S. HULBERT.

Lansing, Mich.

*Queries with Brief Answers.* The answer to query number 19, as given in the last MESSENGER, was carelessly wrong, and a number of our readers were prompt to set us right. It is a pleasure to acknowledge the mistake, and a delight to say the spirit of reproof by these friends, in every case but one, was admirable and generously kind. Now we hasten to give a better answer on the next page.

*Query 11.* The reason why almanac makers use the word *morn*, in case of the moon's rising or setting, is plain, on proper reflection. Let the proposer of the query look in some calendar for October, 1889. On the 18th he will find *morn*. The 17th gives 11*h* 42*m* for the rising. Opposite the 19th he will see 41*m*, which of course denotes so many minutes past 12; but the intervals between the risings is only one hour; and one day *plus* one hour from Thursday night 11*h* 42*m* throws the rising past midnight on Friday, and hence is counted as Saturday morning. So when two successive settings occur, one on each side of midnight, the like skipping of one day takes place. The moon does not rise at all on Friday, Oct. 18, 1889. R. W. M.

*Query 19.* The answer printed in the August number is incorrect. Evidently the inquirer asked the common time; and that is midnight of Dec. 31, 1900. This is so plain and simple a matter that it is cause for wonder that anyone could be in doubt on the subject. The year is always the *current*, not the *complete* year. The same is true of the day, —when we say the 31st day of the 12th month, the meaning is the *current* day and month—not 31 days and 12 months. The Christian era is now in its *eighteen hundred and eighty-ninth* year. The 1889 years will be completed at midnight Dec. 31. There was no year zero. The Christian era starts with the year 1, and when 1900 have passed we shall reach the 20th century, and not till then. R. W. M.

30. In reply to the question of S. W. F. in THE MESSENGER for August I enclose the position of 1830 Groombridge:

$\alpha$ 11*h* 47*m* 51*s* $\delta$ + 38*h* 34*m* 37*s*

The star is about 6.5 magnitude. I am of the opinion that S. W. F. will have some trouble in finding it unless he is furnished with an equatorial telescope. The star is in the lower part of the right leg of the Great Bear, and when $\delta$ Ursæ Majoris is on the meridian 1830 Groombridge will be about 19½° to the south and slightly west of the former star. It might be located from Cor Caroli. It is about 16° west and directly south of that star. It is also near a nebula of a pale white tint and quite bright. It should be in the field with the nebula in an eye-piece that covers 60′ or 70′. G. B. H.

*Photographic Equatorial for Cordoba Observatory.* Messrs Warner & Swasey, of Cleveland, have just completed the mounting of a 12-inch photographic equatorial for Professor Thome of the Cordoba Observatory, Argentine Republic, South America.

*Spectrum of $\chi$ Cygni.* Bright lines were seen in the spectrum of Chi Cygni on May 19, 21; $D_3$ very plain, confirmed by Mr. Taylor at Ealing, England. T. E. ESPIN.
Wolsingham Observatory.

A student interested in elementary algebra finds trouble in solving the following example:

$$x^2 + y = 7$$
$$x + y^2 = 11$$

Possibly some of our readers would like to try it.

## EDITORIAL NOTES.

The beautiful frontispiece which we are able to present this month by courtesy of Professor W. H. Pickering, of Harvard College Observatory, we think will be studied with great interest in connection with the important article accompanying it.

Two excellent articles are already in hand for next month, one by Professor Piazzi Smyth, of England, and the other by W. H. S. Monck, of Dublin, Ireland.

The dome of the new Dearborn Observatory at Evanston is said to be one of the most perfect pieces of mechanism of its kind. It was planned by Professor G. W. Hough. It is to be duplicated for the new Observatory at Denver, Col.

*The Bruce Photographic Telescope*, a doublet of 24 inches aperture and 11 feet focal length, for Harvard College Observatory, will be completed in the near future. The terms offered by Mantois of Paris for the rough disks are satisfactory, and the contract has been signed with A. Clark & Sons of Cambridge, Mass., for the entire instrument.

*Professor Howe's New Telescope.* Professor H. A. Howe, Director of the Observatory of the University of Denver, Colorado, writes recently that the crown glass for his new 20-inch objective is on exhibition at the Paris Exposition. Mantois of Paris, the maker, says he is willing to have the jury decide his rank as a competitor by it alone if they choose. The flint glass is still in the pots.

*Photograph of Jupiter.* Professor W. H. Pickering has favored THE MESSENGER with a reversed positive of the planet Jupiter, mounted for a transparency. The negative was taken on Wilson's Peak, in Southern California, at an altitude of 6,250 feet, by the aid of the 13-inch Boyden photographic doublet, June 21 19*h* 15*m* G. M. T. The exposure was 14 seconds. The scale is 1 : 5,000,000,000. A surprising amount of detail is seen in the positive, the focal image being enlarged to show an equatorial diameter of 29 millimeters.

*New Telescope for Carleton College Observatory.*—A few weeks ago Dr. E. H. Williams, of Philadelphia, most generously donated to Carleton College $15,000 for the purpose of purchasing a new equatorial telescope, of 16-inches clear aperture, for the new Observatory. This noble gift is now in the College treasury, and steps are being taken for the construction of the telescope. There are so many new and interesting questions pretaining to the glasses and the mounting, that we shall not greatly hasten the work, but go only so fast as the best way opens after careful study. It will probably be two years before the large telescope will be in place and ready for work.

The friends of Carleton have reason to rejoice greatly in this another gift by Mr. Williams to this institution, and as the most thoughtful of them ponder it, they well know that whatever the scientific character of this college now is, or may be, its measure of success will be largely due to the generous, Christian spirit of this noble man. These grand memorials, which he has so wisely placed here, will fittingly bring Heaven and earth nearer in gracious power to touch the hearts of the young, with the matchless beauty of the star-depths painted there as the handiwork of God.

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*Recent Papers by Professor William Huggins.* Two excellent papers have recently been published by Dr. William Huggins, of London, with titles as follows: "On the Wave-Length of the Principal Line in the Spectrum of the Aurora," and "On the Spectrum Visible and Photographic of the Great Nebula of Orion." To the last the name of Mrs. Huggins is added as author also. In our last issue appeared a brief article by Professor C. A. Young covering most of the important points; for details the papers themselves should be read.

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*Change in Crater Pliny.* On Sept. 15 telegraphic notice came that an observer in Geneva had noticed a change in the central crater of Pliny. Bad weather at Carleton College Observatory has prevented observation. Attention is asked to this during the next moon. We also suggest that Gassendi be examined carefully, for *l'Astronomie* (France) reports a new crater on its northwest rampart observed July 8, 1888.

*The Observatory Criticises Professor Pickering's Plans for Stellar Photography.* The August *Observatory* (Greenwich, England), in a remarkable manner editorially criticises the plans for stellar photography proposed by Professor E. C. Pickering of Harvard College Observatory. The occasion of our worthy cotemporary's displeasure seems to arise in this way: In November last, Professor Pickering prepared a circular, for special and personal uses, setting forth the advantages of a photographic telescope of 24 inches clear aperture and eleven feet focal length, and briefly showing what such an instrument could do in the promising field of stellar photography. To this appeal Miss C. W. Bruce, of New York City, promptly responded with the munificent gift of $50,000 to procure such a telescope.

The *Observatory* now takes Professor Pickering to task severely for the following reasons: 1st. Because no mention was made of similar work proposed by the International Congress in 1887, in his appeal for funds it is said he has not "put his case before the public in a fair manner;" curiously suggesting also, that some evil-disposed person might charge Professor Pickering with deliberately excluding such mention from his appeal, as likely to be prejudicial to his chances of success in getting the desired money. 2d. That Professor Pickering is setting up a rival scheme to that of the International Congress and thereby opposing and discouraging its great work. 3d. In assuming that he can make a photographic chart of the whole sky in two or three years, with one large telescope, is to say that the united efforts of seventeen observatories to do the same work with smaller telescopes, is all wrong. 4th. That, by his course, Professor Pickering "has re-peopled the world with critics whose attention is distracted from the research by the manner in which it has been endowed."

As a whole, this is the most remarkable criticism by men of acknowledged ability that we ever saw. Surely it does not "mince matters." In a unique way it raises some very grave questions, that lead us to ask what obligation any man is under, in any business, to publish to the world what other men *propose* to do, before he can properly go at the same work in his own way, if he chooses? Or what right have English gentlemen to impugn the motives of any

person and color them up to suit their fancy, and then turn round and politely ask the accused to say whether or not that is a true picture of himself? It is difficult to imagine what provocation would justify such conduct.

This so-called "rival scheme" seems to trouble the *Observatory*. Why is this? Is there real fear of one man against the seventeen—one Observatory against the seventeen, possibly of the best in all the world beside?

Another curious feature is the supposed fact that the manner of obtaining $50,000, in America, for endowing stellar photography should re-people the world with critics to harm the work in the eyes of our friends on the other side. We do not believe it will. The International Committee know that Harvard College Observatory has a fine 13-inch photographic telescope, and it is now ready, doubtless, to do its full share of work on the international plan. If that noble Observatory wants to do more, or try different plans for the same kind of work, we say, go ahead, and bid her God speed in it, especially when we know that Professor Pickering has already photographed stars with an 8-inch instrument whose magnitudes are as small as the limit of those contemplated by the International Congress.

Whether this large photographic telescope of 24 inches aperture can be made or not, as our friends seem to doubt, we do not know, but we do know, that the disks are already contracted for, and that the Clarks have agreed to make the lenses. Time will soon test all these interesting questions.

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*Total Solar Eclipse Expedition for Dec., 1890.* An expedition to West Africa to observe the total eclipse of the sun which will occur Dec. 21–22, 1889, is now being organized in Washington, D. C., with headquarters at the Navy Department. Secretary Tracy has placed the entire management of this expedition in the hands of Professor D. P. Todd, Director of the Observatory of Amherst College, Mass. It is too early to speak of the personnel of the expedition, as but few are yet named. It is probable, if not certain, that Professor Bigelow, of the Nautical Office, Dr. Holland, Professor Agassiz, Mr. Orr, and Professor Loomis and Harvey Brown from the National Museum are among the persons already chosen.

Harvard College Observatory and the Massachusetts Institute of Technology are to loan some instruments for the service of the expedition. The plans, so far matured, seem to cover a wide range of work, as this will probably be the most favorable eclipse for observation (if the weather at the time is propitious) that will take place for a few years to come. Professor Todd is anxious, of course, to obtain all the observational data possible in this early opportunity, and we believe he will spare no pains to make the expedition successful in all ways.

The path of totality of this eclipse touches the west coast of Africa at 10° south latitude, and near the city of St. Paul Loanda, two or three hundred miles below the mouth of the Congo River. The expedition will land at this city and choose its point of observation probably at some distance beyond, near the central line of the shadow.

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*Astronomical Photography*. The fourth part of the Bulletin of the Permanent International Committee on the Photographic Chart of the Sky is just at hand. It contains valuable papers by Dr. Scheiner, J. C. Kapteyn, Dr. H. C. Vogel, David Gill, and E. Renz, on subjects of investigation connected with the great project. The paper by Dr. Scheiner, of Potsdam on "The Application of Photography to the Determination of Stellar Magnitudes," giving results of measurements of plates exposed by E. von Gothard at Hereny, and by himself at Potsdam, is specially interesting. The paper also by Dr. Vogel, describing the new photographic refractor recently constructed for the Observatory at Potsdam by the Repsolds is of great interest and importance. This instrument has two objectives and eye-piece and plate-holder in the same tube, conforming to the resolutions of the congress in 1887, but the peculiarity is in the form of mounting, which is quite different from the English and German forms. The pillar which supports the polar axis is not upright, but L-shaped, the lower part being inclined nearly in the plane of the equator, the upper almost at right angles to this, extending toward the north pole and enclosing the polar axis. The support possesses very great stability, and its form permits an *uninterrupted motion of the telescope in all positions*. The

English form of mounting, which was adopted by the Henrys, does not permit the telescope to be directed toward the polar regions. The German form does not permit the telescope to pass the meridian near the zenith without reversal, the tube striking upon parts of the pillar. The Repsolds, in their new form of mounting, have avoided both of these difficulties.

The President of the Bureau, E. Mouchez, after calling attention to the reunion of the Permanent Committee to be held in Paris Sept. 15, and the new Astrographic Congress at Bruxelles the following week, gives a brief report of progress already made and a list of questions to be considered at the meeting. He says, "According to some reports received it seems that the results obtained with the photographic objectives constructed in other countries are not so satisfactory as ours, especially in regard to the extent of measurable field. If this be so there will be a troublesome cause of delay for several of the observatories which should take part in the construction of the chart of the sky and the catalogue.

"The seven instruments, the construction of which was given to Messrs. Henry and Gautier, are finished. The three destined for the French observatories of Bordeaux, Toulouse and Alger have been delivered, and the four for La Plata, Santiago du Chili, Rio de Janeiro an San Fernando are also finished and in course of shipment. These seven observatories, with that of Paris, will be ready to commence work in the first half of the coming year." H. C. W.

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*International National Congress on Celestial Photography.* By courtesy of Mr. A. A. Common, vice president of the International Congress on Celestial Photography, we have a circular giving a programme of meeting appointed for Sept. 20. It is as follows:

PROGRAMME.

*Sun.*—The establishment of an understanding between Observatories with a view of obtaining an uninterrupted series of Solar Photographs of uniform plan, giving the condition of the Sun's surface several times a day.

A systematic Photographic Study of the Solar Spectrum.

*Moon.*—Systematic study by Photography of the surface of the Moon, in order to obtain a complete delineation of the whole visible surface of our Satellite.

*Planets.*—Photography of Planets and their Satellites, for physical features and measurement.

*Meteorites and Shooting Stars.*—Study by Photography.

*Comets.*—Photography of Comets during the whole course of their appearance.

*Star Clusters.*—Photography for purposes of description and measurement.

*Stars.*—Photometric study of Stars by Photography.

Special Study: Stellar Spectra, for classification and measurement.

*Nebulæ.*—Descriptive Photography and Photometry.

Searching for Nebulæ by Photography. Preparation of documents enabling the detection in the future of any modification of form which may arise.

GENERAL QUESTIONS.

Instruments to be employed in each case.

Suitable methods for obtaining an exact definition of the conditions under which the Celestial Photographs are obtained so as to allow of comparison in the future.

Reproduction of negatives and multiplication of copies.

Preservation of negatives and copies as photographs.

Measures to be taken in order to ensure the preservation of these documents in public collections.

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*Professor Loomis' Will Bequeaths over $300,000 to Yale University.* By the Will of the late Professor Elias Loomis, Yale University is ultimately to come into the possession of over $300,000. After special bequests to relatives the following provisions of the Will relate to the University and the Astronomical Observatory:

An elegant picture of the deceased, painted by Mrs. H. A. Loop, of New York, is given to Yale to be kept in the Astronomical Observatory.

All the professor's books and pamphlets which relate to mathematical and physical sciences go to the University Library.

After bequeathing certain books, manuscripts, etc., to a son, all the remainder of his property goes to Yale University in trust. One-third of the income from this trust fund in the care of Yale is to be given to Henry Bradford Loomis, another third to his other son, Francis E. Loomis, who is in Europe in very delicate health, and a third to the Yale Astronomical Observatory.

Upon the death of each son the one-third of the income from the trust fund they are entitled to while living goes to the Yale Observatory.

The income of said trust fund, which is to go to the use of the Observatory, as above provided, may be applied, at discretion of Yale University, in any year, to all, or one, or more of the following objects, namely: The payment of salaries of observers whose time is exclusively devoted to the making of observations for the promotion of the science of astronomy, or to the reduction of astronomical observations, and their discussion in papers prepared for publication, or to defraying the expenses of publishing these observations. If, in any year, the income of this trust fund, which

he desires to be forever kept as a distinct fund by the name of the Loomis fund, available for the use of the Observatory, shall be more than sufficient to provide for the above named objects, the excess of income shall be added to the principal and shall thenceforth form an integral part of this fund.

Henry Bradford Loomis is named as executor. The treasurer of Yale college is executor ex-officio.

Provisions like these for the endowment of scientific research are eminently wise, and are gaining the attention of the public more and more in recent years.

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*The Velocity of Sound Mathematically Completed* (*From Newton's Demonstration*) *and shown to be not seriously modified by Heat.* PROPOSITION I. Newton taught that the whole air-tension, from its averaged weight-height A ($\frac{P}{w}$) is the pulse-force producing the wave-length or velocity of sound in air.

PROPOSITION II. Newton was right in thus treating air-tension P (or weight A), and not its mere increase ($P' - P$) by condensing vibration, as the pulse-force producing velocity of sound, V.

PROPOSITION III. The fact that the whole air-tension A (or $\frac{P}{w}$) is the pulse-force producing its velocity, at once annihilates the pulse-heat theory, which regards the velocity of sound as greatly increased by vibrational heat.

PROPOSITION IV. Instead of any great addition of velocity from heat, the true filling out of the Newtonian value is the mere supply of a slight mathematical deficiency, one little item overlooked in Newton's demonstration. Namely, the fact that the work of pulse-force A (as an already acquired tension) is by instant *stroke*, instead of steady pressure (as reckoned,—whereby its efficacy in pulse motion or velocity of sound is increased $\sqrt[4]{2}$-fold, *i. e.*, to 1.19 of its Newtonian value, or from 916 to 1090 feet per second, as the facts of nature require.

A CHALLENGE.

After the most thorough, and long-continued, and oft repeated examination and demonstration of the case, I now call upon the scientific world to meet the issue here made, and either disprove the ground here taken or else accept it as the truth. Which of the four propositions above does anyone call in question? Each candid expert should answer, that we may know in what direction to spend our labor,

and furnish our argument. I deem this a serious matter; and it is high time for our current science to be proved right, or set right, upon this important point. Correspondence is kindly solicited, SMITH B. GOODENOW.

Battle Creek, Iowa.

*Stonyhurst College Observatory.* The report for 1888, giving the results of meteorological, magnetical and solar observations, made at Stonyhurst College Observatory, by Rev. S. J. Perry, S. J., D. Sc., F. R. S., has been received. It is a neat pamphlet of 99 pages of the usual form of Father Perry's reports of this kind that have been issued for several years past. The work of this Observatory is known in both hemispheres.

*Professor H. V. Egbert* has recently been appointed to the position of Professor of Mathematics and Astronomy in Buchtel College, Akron, Ohio, in the place of Professor Chas. S. Howe who has resigned. Mr. Egbert is well and favorably known very generally in lines of his chosen pursuits and he comes to his new field amply qualified for it.

## BOOK NOTICES.

ZENOGRAPHICAL FRAGMENTS. I. The Motions and Changes of the Markings of Jupiter in the Apparition of 1886–87, by A. Stanley Williams, F. R. A. S. London: Publishers, Messrs. Mitchell & Hughes, 140 Wardour Street W. 1889. pp. 118.

In the study of the surface markings of Jupiter Mr. Williams used a silver-on-glass reflector by Calver, 6½ inches in aperture and equatorially mounted, with magnifying power 170. The observations were principally designed to effect two objects. 1st, to fix the zenographical longitudes of the different spots; 2nd, to record the magnitude, intensity and appearance of the various markings diversifying the disk of Jupiter. In the first section is given the method of observation, delineation and reduction; in the second is shown how the construction of the chart of the markings is made; in the third the general arrangement of the Jovian belts and markings of 1886–87; fourth, observations of individual markings with remarks on their motions and changes; fifth, summary of rotation periods, mean motion of matter at different latitudes in 1887; sixth, relative atti-

tudes of different Jovian markings, and seventh, on the repellent influence apparently exerted by the Red Spot.

By a mere glance at these topics, it will be seen at once that the author is dealing with themes on which the student of astronomy desires knowledge, and hence new and useful studies will be most welcome everywhere. The latitude of the different belts in the first plate are said to be not fully satisfactory because determined from a limited number of drawings of the entire disk of Jupiter, and that it should be remembered in comparing these drawings with others that the maps are reduced to some particular date and show the face of the planet as seen at that date. This is important if the reader remembers that the equatorial spots make a complete revolution on the surface of the planet, relatively to the Red Spot, in an interval of 45 days.

In the body of this book there is much of detail in relation to the north and south temperate and equatorial spots, the study of which give strong hints of physical characteristics of prominent surface markings, especially that of the Great Red Spot which has attracted so much attention everywhere since 1879. The accompanying lithographic plates are excellent features in the author's plan, and if accurate would be invaluable for future reference. The first plate is 12 inches by 5½ showing a zone of belts and spots to 50° north and south of the Jovian equator. The remaining seven full page plates show different phases of the more prominent markings observed during the period of their studies. Our readers will be interested to compare this work with that so well done by Professor Hough, of Dearborn Observatory, now located at Evanston, Ill.

This book is certainly a valuable contribution to the study of the Giant Planet that Americans will appreciate.

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The *National Magazine* is the name of a new literary venture of Chicago, which begins with October number. It is published under the auspices of the new "National University," which opens October 1st, of which it is organ. The first number will contain articles on literary, educational and scientific subjects, and a prospectus of the University, which is said to be modelled after the London University and has extensive non-resident courses, teaching many subjects by mail. Published at 182 Clark Street.